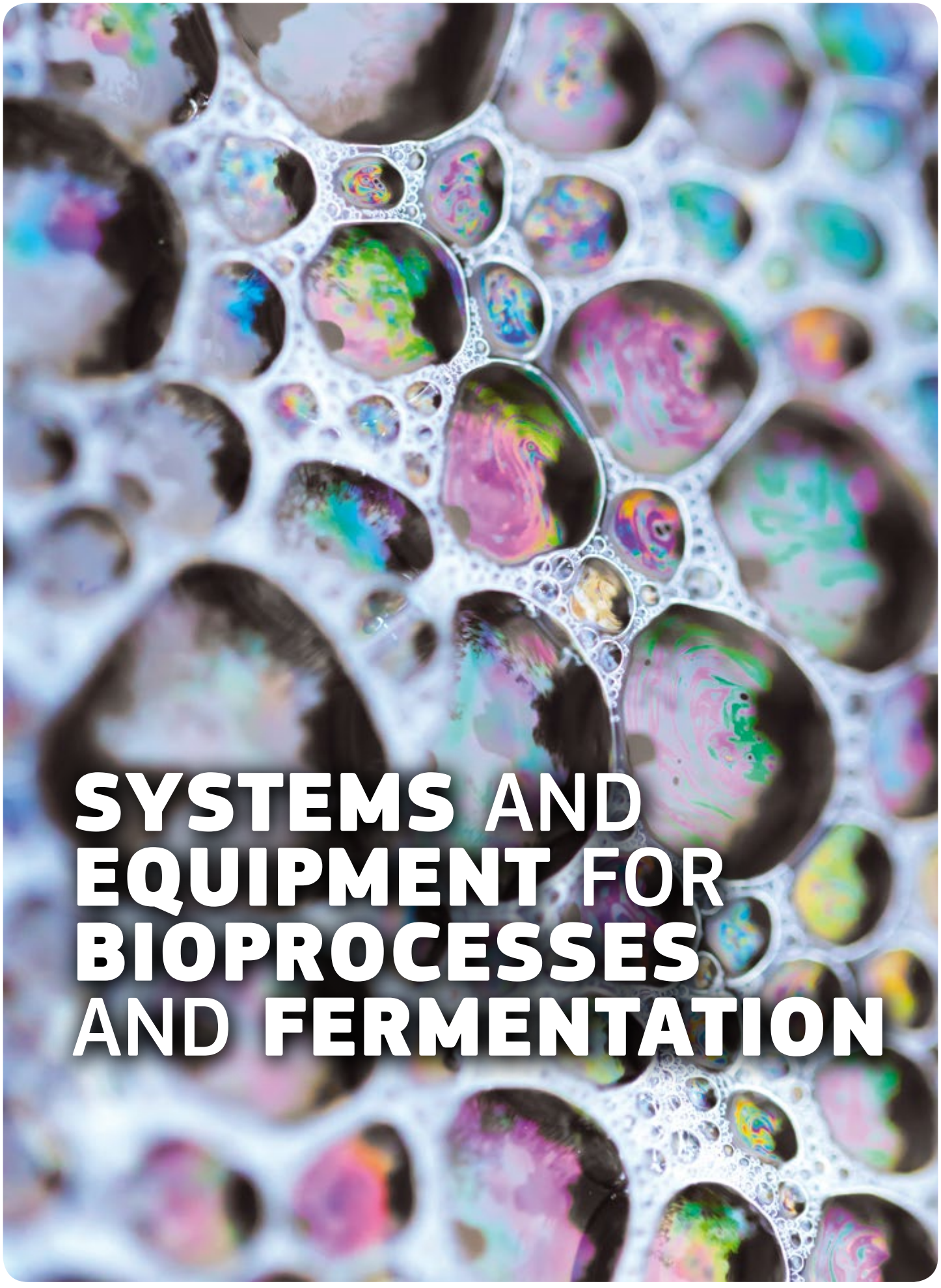


SYSTEMS AND EQUIPMENT FOR BIOPROCESSES AND FERMENTATION

TRL INSTRUMENTS

Process Design

Wide range of body material options for key applications in bioprocesses: borosilicate glass, stainless steel, PTFE or PTFE lined. Batch, continuous or fed-batch systems are available in aerobic or anaerobic conditions.

Reaction Volume for Every Biological Processes

Starting from small volume 0.5 L for cultivation and up to 50 L for lab/pilot scale bioprocess operations.

Autoclavable Parts

For small size culture vessel sterilization; glass vessels, all piping and sensors are compatible with autoclave.

Sterilization In Place (SIP)

All types of culture vessels can be sterilized via steam generator. Fully automated SIP system is safe and simplifies the sterilization required for precise microbiological/cell/tissue applications.

Multiple Vessels for Cultivation / Fermentation

Multiple reactor vessels with different volumes and conditions can be controlled by a single control unit and software. Cultivation operations can be carried out easily by transferring substances from small volume reaction vessel to high volume vessel.

Monitoring and Control

Work Stable for Cell Health

Precise and stable control of working parameters have a key role in biological processes. Sensitive control of parameters, namely pH, temperature, dissolved oxygen, conductivity, redox with high quality sensors.

Aeration Control

Automatic flow control of the gas used as inlets. Can easily be adapted the top cover and sparged into the liquid phase. Does not require manual adjustment.

O_2, CO_2, air and N_2 gas inlets are available for cell culture applications.

For precise DO control, two gas lines (N_2 and air) are available.

High Precision Pumps

Built-in high quality peristaltic pump for precise control of pH, liquid level, feed, discharge and transfer. FDA approved bioprene and stainless steel tubing are selected for sterile microbiological applications.

Thorough Mixing

Baffle enhanced efficient mixing preventing vortex formation. Adjustable speed with high/low torque options.

Sterile Bioprocess Operations

Working with fungus, bacteria, mammalian cells, insect cells, plant cells and microorganisms for the application of any microbiological applications, e.g. cell culture, biopolymer and biogas requires sterile operation with hygenic conditions. We carefully select all parts of the bioprocess reaction system, suitable for autoclave and/or fully automated SIP. FDA approved bioprene and stainless steel tubings are selected for transfer pipes, fittings and lines. These details therefore, allows precise and sterile operations.

Control Module

- Precise control of the whole bioprocess system
- Single or multi-vessel control with one unit
- Vessels can be operated in series or in parallel
- Built-in peristaltic pumps for controlled operations by means of pH, foam, level, transfer, feed and discharge
- Fast responsive feedback loop for precise working parameter control
- Adjustable gas flow meter via manual or software controlled
- Fast response data acquisition interface to software
- Recirculation of externally thermostatted media, an immersion resistance heater or hot plate in the reactor for precise control of the reactor temperature

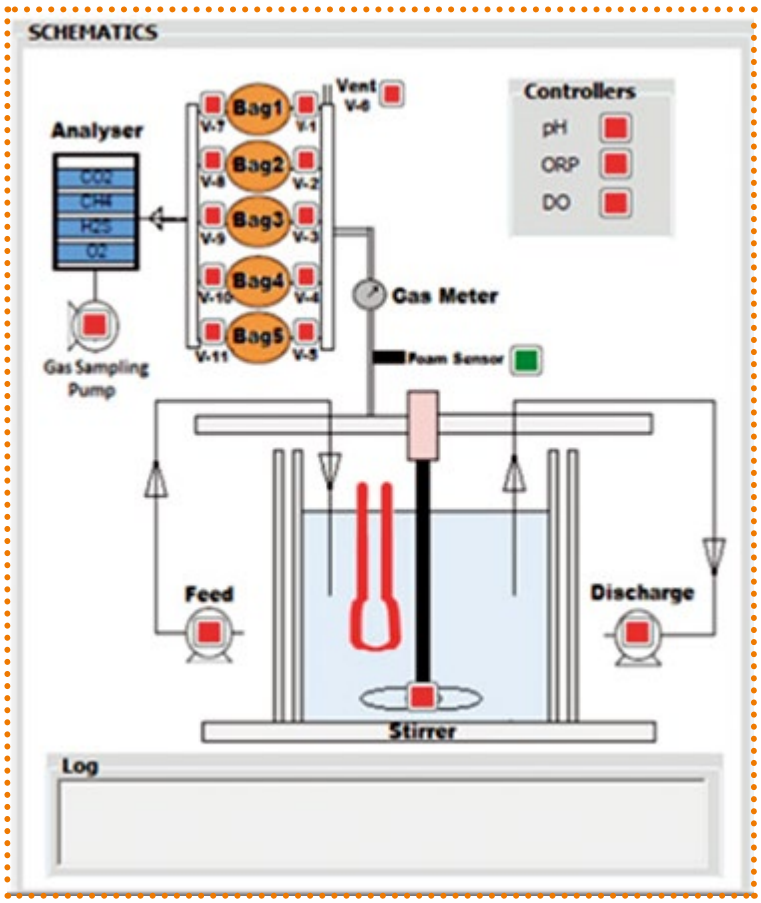
Customizable Gas Analysis

The analysis of gases during bioreaction can be carried out precisely and specifically on % or ppm bases in real time. Besides the determination of specific gases like, CH_4, CO_2, O_2 and H_2S, different options such as mass spectrometer can be attached to the system according to the costumer needs.

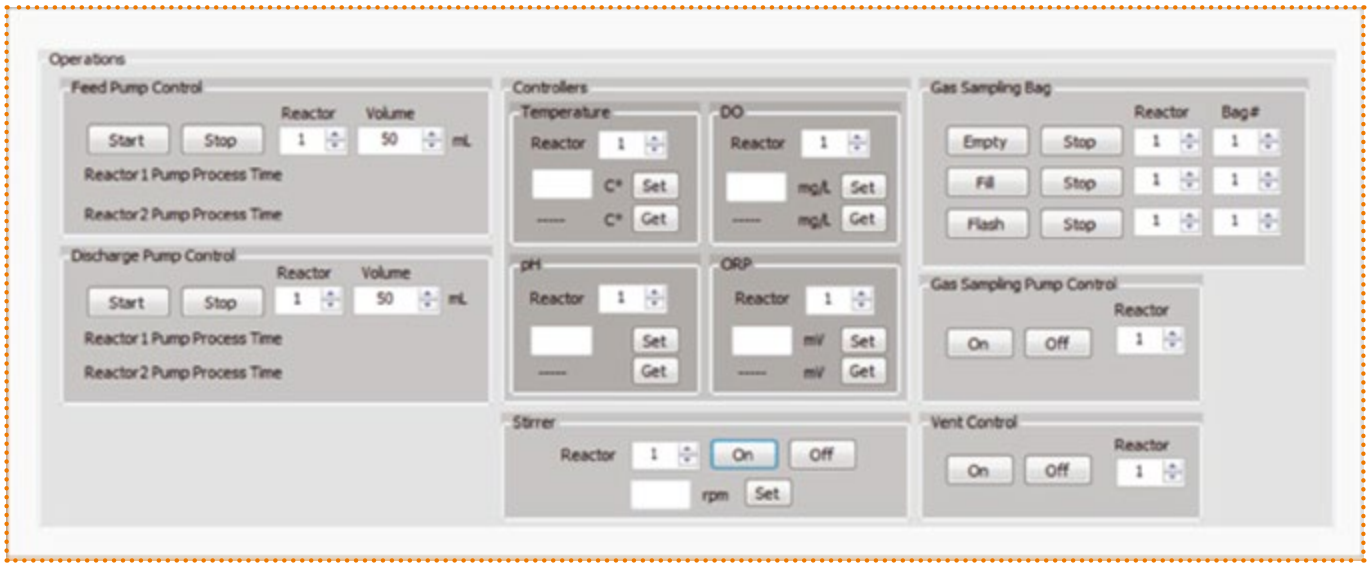
Gas outlet of the bioreactor can also be collected via Tedlar Bags to be further analyzed by various analysers.

Software Features

User friendly software shows the whole system status with an easy interface and fast response, running on Windows®



- Real time monitoring of the whole system
- Real time continuous display of the working parameters
- Combined report possibility
- Export to external data analysis software e.g. Excel
- Set all the working parameters and analyses immediately with fast feedback control interface
- One click switch between reactor vessels to check and display reactor status
- Safe startup and shutdown of the system through the software
- UPS supported operating software takes the system into safe mode in case of a power failure
- One software is enough to control all reaction vessels



Wide Range of Applications

Bioreactor / Fermenter systems are ideal for microbiological applications. With wide variety of material and reaction set up options, following main applications can be carried out:

> Process development and optimization

> Scale-up and scale-down studies

> Basic and advanced research

> Education

Cell Culture

The cultivation of animal or plant cells have an important role in for the medical applications, e.g. therapeutics and diagnostics research and production.

The use of *mammalian cells, insect cells and plant cells* to produce; viruses, recombinant proteins, monoclonal antibodies and vaccines for the fields of medicine.

The growth of these cell cultures is slow compared to bacterial growth, therefore cell culture should be prepared in suitable and controllable medium and temperature.

We can meet all the requirement for sensitive cell culture application by means of sterilization and homogeneous temperature distribution.

Biofuel

The production of biofuels, such as bioethanol and biodiesel from algae, plant materials, biomass or solid phase cultivations need extensive process development.

Considering the special requirement of biofuel production, such as aerobic/anaerobic conditions, temperature control, effective mixing for heat distribution and especially gas analysis should be adapted to specific applications.

From 0.5 L to 50 L bioreaction system, it is possible to optimize process conditions and make scale-up studies. Precise control of temperature and mixing, specific gas analysis and multi-vessel bioreaction options make our bioreaction system is a perfect tool for biofuel applications.

Microbial Fermentation

Microbial fermentation has a key role in producing a specific chemical product as well as food and beverage components.

Fermentation is a metabolic process / enzymatic decomposition for proteins, enzymes, secondary metabolites, carbohydrates production by microorganisms, such as *bacteria* and *fungi*.

This high-density culture process need powerful mixing, good temperature and dissolved oxygen (DO) control and effective feeding system.

Requirements for maintaining DO level at desired value, precise temperature control for microbial health, several feed options for addition of different agent at different times and powerful mixing can be met by our bioreaction systems.

Waste Treatment

Bioreaction systems can be aerobic / anaerobic digester tool for waste treatment industry. Key factor for the bioprocess is to maintain the reaction medium controlled.

The use of *microalgae* for the removal process of the solid containing sludge waste nutrients has several advantages. Biological nutrient removal from industrial and domestic wastewater streams can also produce sustainable biofuels.

The removal of dyes from industrial wastes is also possible with bioreaction systems by *Bjerkandera adusta* fungus. In a well-controlled environment, this fungus resulted effective during 10 cycles of decolourisation.

Biopolymers

Waste accumulation generated from day-to-day applications of polymer materials such packaging and construction growing enormously. Biopolymers are polymers that are biodegradable and be produced from renewable sources.

The production of biopolymers from bacteria e.g *Cupriavidus necator* need controlled and monitored environments by means of sterilization, pH, temperature, DO and good mixing.

Biogas

Any renewable energy source is regarded as exceptionally important in our modern society. Biogas, denotes gases which is produced in the absence of oxygen by the biological breakdown of organic matters with the help of various anaerobic bacteria.

Agricultural waste, plant material, sewage, green waste, municipal waste or food waste are raw materials for biogas production.

Anaerobic conditions with controlled pH and temperature make bioreactor / fermenter systems perfect tool for production of biogas.

The extracted biogas from wastes in desired reaction conditions is a gas mix that consists mostly methane and carbon dioxide. The composition make biogas perfect renewable fuel which can be used to run any type of heat engine to generate electrical or mechanical power.

How to Order Bioreaction System

As the systems are quite versatile, a questionnaire needs to be filled to proceed with specifying a product to quote. Please consult factory for the questionnaire.

Application Areas of Our Products

Bioreaction Systems / Fermenters

Pilot and lab scale bioprocess/fermantation systems that are customized according to customer needs to provide best solutions for customers' applications such as cell culture, biofuel, microbial fermentation, waste treatment, biopolymers, biogas.

Reaction / Sorption Systems

Pilot and lab scale reaction systems, which can contain upstream and downstream conditioning, reaction/sorbtion and analysis units with regard to customer needs, for catalyst research/ development, sorption studies and reaction kinetics.

Carbon and Nitrogen Analyzers

Excellent and unique analyzers for analysis of soil, sludge, biomass, fertilizer, foodstuff, sheet metals, water, coal and minerals for total carbon, total organic carbon, residual organic carbon, surface carbon, inorganic carbon and total nitrogen parameters.

Online TOC-Monitoring Analyzers

Analyzers with very low drift, for quality control and monitoring of total organic carbon in process water, tap water, river water, lakes, drinking water, municipal and industrial waste water.

We:

develop

design

manufacture

processes and equipment, for:

research

production

analysis

in the field of:

reaction engineering, sorption studies and catalysis research

environmental monitoring

bioprocesses

for:

development of future energy resources and processes

protection of environment

TRL INSTRUMENTS

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